REMARKS

In the Office Action mailed June 4, 2003, the Examiner noted that claims 1-17 were pending, and rejected all claims. New claims 18 and 19 have been added and, thus, in view of the forgoing, claims 1-19 remain pending for reconsideration which is requested. No new matter has been added. The Examiner's rejections and objections are traversed below.

Prior to a discussion of the details of the rejections, a summary of the invention and the problem being solved by the invention will be provided to assist in the understanding of the points later made herein.

The present invention is directed to improving display quality. Pseudo contours particularly degrade display quality and a reduction in pseudo contours, as in the present invention, produces enhanced display quality.

Original frame data indicates a gradation or level of each pixel in an image. Display frame data, on the other hand, defines light emission timing for each light emitting cell in a display. In a device where a display cell is a binary light emission type element (on/off), such as in a PDP, luminance is controlled via making light emission by the cells intermittent. Typically a sub-frame division method is used in which display periods having different lengths are assigned to a frame period to determine the periods in a frame during which each cell is lighted. For example, referring to figs. 5 and 6, original frame data specifies that pixels maintain a specified constant brightness during an entire single frame period (type A). However, since the intermittent display periods in a frame are spread over a period of time, this constant brightness requirement is not satisfied. In fig. 6, three light emissions are provided during the frame to realize a display brightness that is close to the desired constant brightness requirement. In this case, the light emission waveform is a waveform in which three rectangular pulses having different pulse widths are provided during the frame. An address period is also required to control lighting/not-lighting during each display period, and a display discharge is not produced, that is no light is produced, during the address period of each sub-frame. Accordingly, even if cells are lighted during all of the display periods available in a single frame, the cells are not lighted throughout the single frame period because of the address period during which no light is produced. This causes a problem.

This problem is an error that inevitably occurs between a target light emission waveform defined by the original frame data and an actual light emission waveform determined by the

display frame data. The error depends on how the original frame data are associated with or mapped to the display frame data. The present invention provides a method for using a processor to perform a data conversion, from original frame data to display frame data, in which an error between a target light emission waveform or a target gradation waveform (defined by the original frame data) and an actual light emission waveform or an actual gradation waveform (defined by display frame data) is minimized such that pseudo contours do not easily arise.

According to the present invention, a Fourier expansion is performed to determine the error between the waveforms by resolving the error into plural frequency components. In reducing the error, it is important that a human should not feel that the display is somehow unnatural. Reducing the error in specific frequency components rather than reducing the error uniformly across plural frequency components allows error reduction without causing the display to appear unnatural. For this reason, the Fourier expansion is weighted in accordance with human vision characteristics.

In particular, Fourier expansion is performed for each of a plurality of display frames such that a sum of error components, with weights, is minimized. This allows the error reduction to reduce contours without making the display appear to be unnatural.

In the present invention, instead of processing one frame, image information from a current frame and a previous frame are combined into a unit to perform the Fourier expansion. Since pseudo contours are generated in an active display in which plural frames are involved, processing plural frames as one unit is particularly effective in reducing pseudo contours.

Page 2 of the Office Action rejects claims 1-16 under 35 U.S.C. § 103 over Mikoshiba and Matsushiro.

As discussed above, the present invention is directed at removing pseudo-contours or false contours by controlling an intensity of light produced in the frames (type A) or in the sub-frames (type B). The light luminance of each frame/sub-frame is selected based on a difference or error between a target luminance waveform and the existing/current luminance waveform. A Fourier expansion of the error is obtained. This expansion is weighted according to human eye sensitivity and so that the sum of the weighted errors is minimized. The weights are used to set the luminance of the current frame or sub-frame data.

The present invention is very different from the system of Mikoshiba.

Mikoshiba is also trying to prevent false contours. However, Mikoshiba does so in a very

different way than the present invention. In Mikoshiba a motion vector A for halftone image motion between frames is produced. That is, the motion velocity and direction of the images from frame to frame is determined (see col. 14, lines 3-10). A light emission delay time (tn) between a particular sub-frame and the first sub-frame is determined. This delay time is divided by a frame period tF producing the number or scalar value tn/tF. Mikoshiba calls this number (tn/tF) a control function. The motion vector A is multiplied by tn/tF. In this situation, the length of the motion vector is changed. This motion vector is used to move the image in the sub-frame to this calculated position (see col. 14, line 50). Each sub-frame thereby has an individual motion vector (see col. 14, lines 27-28). Mikoshiba reduces false contouring by moving the image in the sub-frames using sub-frame motion vectors calculated at the sub-frame level.

This is very different from controlling the luminance waveform as in the present invention.

In making the rejection, the Examiner appears to be interpreting the "tn/tF * * A" as a waveform. This is not an accurate interpretation. A motion vector (direction and distance) multiplied by a scalar does not produce a waveform, it produces another, different length vector. It is possible, though it is submitted to be unreasonable, that the Examiner may consider the individual sub-frame motion vectors An to be creating a waveform within a frame. Even if this is the case, it is a position waveform and not a light intensity or emission waveform, as in the present invention.

Mikoshiba discusses position changes to reduce contours not light emission waveform changes. Mikoshiba particularly does not teach or suggest "performing Fourier expansion of an error between the determined light emission waveform and a target light emission waveform defined by the original frame data corresponding to the determined light emission waveform" as emphasized in claim 1 (see also claims 8, 15 and 16).

Matsushiro discloses (see col. 3, lines 57-67) setting of quadrants in a pattern matrix in the equal positive and negative intervals. Matsushiro does not teach or suggest, "performing Fourier expansion of an error between the determined light emission waveform and a target light emission waveform defined by the original frame data corresponding to the determined light emission waveform," as recited in independent claim 1 (see also claims 8, 15 and 16) of the present invention.

On page 11 of the Action the Examiner particularly asserts that Matsushiro teaches the use of Fourier expansions referencing Matsushiro at col. 3, line 62. This is not the case. Matsushiro does not teach use of a Fourier expansion much less one where the error

components between curves are determined and used to control light emission as in the present invention, Matsushiro instead merely suggests that the alternating positive-negative pattern of a Fourier series can be used in a pattern matrix. As particularly stated in Matsushiro:

> The reason for placing numbers with substantially equal absolute values in horizontally adjacent quadrants is to obtain an equal balance between positive and negative offsets in each horizontal scanning line, similar to the equal positive and negative intervals of the sine functions used in Fourier-series expansions. The reason for making the sum of the four quadrants substantially equal to zero is to avoid changing the overall darkness of the image. If the sum of the four quadrants were much less than zero, the image would be noticeably lightened; if the sum were much more than zero, the image would be darkened.
> (See Matsushiro, col. 3, lines 57-67)

Matsushiro merely describes a taught technique as being similar to a part of a Fourier expansion. No use of the Fourier expansion as in the present invention is suggested.

On page 12 of the Action, the Examiner alleges that Matsushiro teaches "the weight of each Fourier component, of a frequency above a flicker frequency, is set to "0" citing col. 3, line 57 - col. 4, line 41). This, however, corresponds to setting a weight for each component and does not mean that a sum of error components with weights in a Fourier expansion is minimized as is called for in claim 1. (See also claims 8, 15 and 16)

The combination of Mikoshiba and Matsushiro does not teach or suggest the features of claims 1, 8, 15 and 16.

It is submitted that the invention of independent claims 1, 8, 15 and 16 distinguishes over the prior art and withdrawal of the rejection is requested.

Page 10 of the Office Action rejects claim 17 under 35 U.S.C. § 103 over Okajima and Tanaka.

Okajima is directed to a system that stores sub-field (or sub-frame) luminance values for a prior frame and for a frame in front of a prior frame. These two luminance values are used to determine a present or current sub-field luminance value. Okajima does not teach or suggest "performing Fourier expansion of an error between the determined light emission waveform and a target light emission waveform defined by the original frame data corresponding to the determined light emission waveform" as recited in claim 17.

Tanaka is directed to a system in which the Fourier expansion is used to help control flicker. There is no suggestion that the Fourier expansion can be used to control pseudo or false contours much less doing so using an expansion of the error or difference between curves as in

the present invention of claim 17.

It is submitted that the invention of independent claim 17 distinguishes over the prior art and withdrawal of the rejection is requested.

The dependent claims depend from the above-discussed independent claims and are patentable over the prior art for the reasons discussed above. The dependent claims also recite additional features not taught or suggested by the prior art. For example, claims 7 and 14 emphasize the target waveform being a linear approximation of transitions in target emission values. Noth9ng in the prior art teaches or suggests this. It is submitted that the dependent claims are independently patentable over the prior art.

New claims 18 and 19 emphasize control of the emission waveform responsive to human eye sensitivity. Nothing like this is suggested in the prior art.

It is further submitted that the claims are not taught, disclosed or suggested by the prior art. The claims are therefore in a condition suitable for allowance. An early Notice of Allowance is requested.

If any further fees, other than and except for the issue fee, are necessary with respect to this paper, the U.S.P.T.O. is requested to obtain the same from deposit account number 19-3935.

Respectfully submitted,

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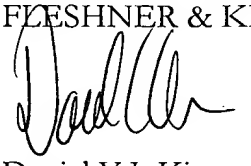
additional changes would place the application in better condition for allowance, the Examiner is invited to contact the undersigned attorney, David C. Oren, at the telephone number listed below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this, concurrent and future replies, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
FLESHNER & KIM, LLP



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